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GETTER OPERATING AT VARIOUS TEMPERATURES TO OCCLUDE VARIOUS GASES

Filed June 19, 1961

FIG.1.

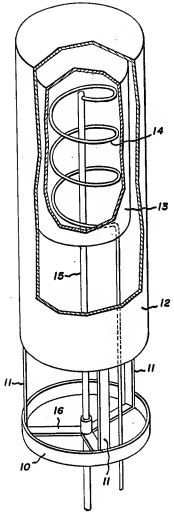


FIG.2.

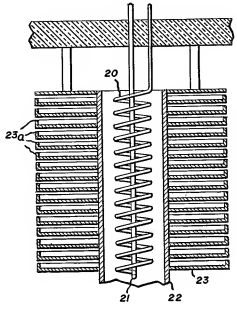
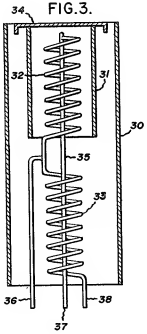


FIG.3.



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3,167,678

GETTER OPERATING AT VARIOUS TEMPERATURES TO OCCLUDE VARIOUS GASES

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This invention relates generally to gettering devices and pertains more particularly to an independently controlled gettering device for an evacuated chamber.

While for many purposes a chamber can be evacuated by mechanical means to an extent adequate for such purposes, some chambers such as the envelope of an electron discharge device require a higher degree of vacuum than can be obtained by the usual mechanical devices. It has become common practice in industry to include within the envelope of such a device a so-called getter material which will sorb or getter the gas molecules which may be left within the envelope after evacuation or which may be subsequently released from the structures within the envelope. Often the getter material is selected from the materials included in Group IV of the Periodic Table which includes, for example, titanium, zirconium and hafnium.

As is well known, gas-sorbing capacities of these getter materials, and thus the rates at which these getter materials are effective to sorb gases, are enhanced when the materials are heated. This heating of the getter material can be effected by placing it adjacent a normally heated element in the device to be evacuated or, alternatively, an independent getter heating element can be provided which can be controllably energized at intervals during the life of the device.

It is an object of this invention to provide an improved gettering device the action of which can be controlled as desired.

It is also an object of this invention to provide a gettering device which will effectively sorb gases which tend to be sorbed at high temperatures as well as gases which tend to be sorbed at lower temperatures.

It is a further object of this invention to provide a gettering device which will effectively sorb a plurality of gases, each of which may tend to be best sorbed at a distinct different temperature.

Briefly stated, in carrying out the objects of this invention in one form, a getter structure is provided in which a heater element is positioned within a chamber to be evacuated. A getter element comprising a first cylinder of gettering material is provided in the structure and is positioned about this heater so as to be heated thereby when the heater is energized. Another getter element comprising a second cylinder of gettering material is included in the structure and is positioned about the first cylinder so that the second cylinder is thermally shielded from the heater and will therefore be heated to a lower temperature than the first cylinder. The outer cylinder can be longer than the inner cylinder for thus disposing a section thereof more remote, and thus more thermally isolated, from the heater contained in the first cylinder. As an alternative form the heater can comprise a plurality of independently controllable sections with one heater section essentially determining the temperature of the inner cylinder and the other heater section essentially determining the temperature of the extending section of the outer cylinder. In another alternative form the outer cylinder can be replaced by a plurality of axially spaced washer-like elements of gettering material and which are adapted for having portions thereof varying in temperature in accordance with the radial distance from the inner cylinder. Additionally, the washer-like elements can be provided with cylindrical outer rim portions effective for

minimizing radiated heat loss thereby to conserve power and for serving to minimize outward migration to other elements in the device of volatile gettering material.

The invention will be better understood from the following description taken in connection with the accompanying drawing in which:

FIGURE 1 is a schematic perspective and partially cut away view of a getter structure embodying one form of this invention;

FIGURE 2 is a schematic sectional view of a gettering device constructed in accordance with a second embodiment of this invention; and

FIGURE 3 is a schematic elevation of a gettering device constructed in accordance with a third embodiment of the invention.

Referring now to FIGURE 1, a gettering device is illustrated which is mounted upon a supporting ring 10. Fixed to the supporting ring 10 and extending upwardly from it are a plurality of supporting legs 11. An elongated inverted cup-shaped member 12 formed of gettering material is securely mounted at the upper ends of the supporting legs 11. It has been found that titanium, hafnium, and zirconium, or materials comprising one or more of these metals, are particularly suitable for use as gettering materials in this invention; however, other metals in Group IV of the Periodic Table may be efficaciously used for some applications. In addition to the use of these metals in a substantially pure state, alloys, for example, of the type disclosed in U.S. Patent No. 2,926,981 of V. L. Stout et al., issued March 1, 1960 and assigned to the same assignee as the present invention are usable for some purposes in the application of this invention. A second elongated inverted cup-shaped member 13, also formed of suitable gettering material is positioned in the cup-shaped member 12. The member 13 can be securely mounted in the described position in any suitable manner. For example, it can be mounted on the inner wall of the member 12. However, if this manner of mounting is employed, it should be carried out by use of means which will minimize heat transfer between the cup-shaped members 12 and 13. It may be desirable to have the outer cup-shaped member 12 have side walls of greater length than the inner cup-shaped member 131 in the manner shown, and for some purposes it may be found preferable to make both cup-shaped members 12 and 13 of the same gettering material. A helical coil heater element 14 is positioned within the inner cup-shaped member 13 and is electrically and mechanically secured at the top to a supporting and conducting rod 15. The rod 15 may be secured to the supporting ring 10 by a plurality of radial braces 16.

In accordance with the invention, the heater element 14 is so positioned as to heat, directly by radiation, the inner cup-shaped member 13. This location of the heater element 14 within the inner cup-shaped member 13 shields the outer cup-shaped member 12 from the higher temperatures experienced by the inner cup-shaped member 13, and, thus, the outer member 12 is adapted for operating at a relatively lower temperature than the inner member 13. Also, when the outer member is longer than the inner member, the outer member includes a section portions of which are relative progressively more remote from the heater than the inner member 13 and the upper section of the inner member which is coextensive with the inner member. In this manner the outer member is adapted for gradient progressively lower temperatures toward the lower end of the device.

The described arrangement therefore makes possible the use of a single heater to achieve a substantially wide range of different temperatures in two getter members. The reason for desiring different temperatures in two getter members arises from the nature of the gettering

process. While most of the active gases will be gettered at temperatures of approximately 700° C. and above, hydrogen will be released by the getter at these temperatures. To sorb hydrogen, the gettering material should be at temperatures of approximately 400° C. or below. The structure of this invention therefore solves the problem of sorbing substantially all the gases (except noble gases) by maintaining one getter member at a relatively high temperature whereby it will sorb all the gases except hydrogen and will tend to emit any hydrogen previously sorbed, and a second getter member at a lower temperature at which the hydrogen will be effectively sorbed.

Referring now to FIGURE 2, a second embodiment of this invention will be described. A longitudinally extending helical coil heater 20 is mechanically and electrically secured at the lower end to a supporting rod 21. Positioned around the heater coil 20 is a cylindrical getter member 22 which can be formed of the same material as either of the above-described members 12 and 13 in FIGURE 1. Secured in axially spaced and stacked relation around the cylindrical getter member 22 are a plurality of annular or washer-like elements 23 formed of a gettering material of the same type as those described above. Both the getter cylinder 22 and the washer-like getter elements 23 will become heated when the coil heater 20 is energized; however, it can be readily seen that the getter elements 23 will be heated to a lesser temperature than the getter cylinder 22 and the elements 23 will vary in temperature in accordance with the radial distance of any portion thereof from the heater. Suitable supporting means 24 may be provided to maintain the heater coil and the two getter members in their proper physically located and electrically insulated relative positions. Additionally, the washer-like elements 23 can be provided with cylindrical outer rim portions 23*a* which are shorter in axial length than the space between adjacent ones of the elements 23. Thus, the rims 23*a* are adapted both for minimizing radiated heat, and thereby conserving energy, and for minimizing outward migration of volatile gettering material which would tend to deposit undesirably on adjacent elements. However, the rims 23*a*, because of the spacing between each one thereof and the next adjacent element 23, allow access to gases to be sorbed to the outer surface of the cylinder 22 and the surfaces of the elements 23.

As was previously described in connection with FIGURE 1, both the getter cylinder 22 and the getter elements 23 may be of the same materials or of different materials depending upon the application to which the device is to be put. In addition, the materials and temperatures mentioned as being suitable for the embodiment of FIGURE 1 may also be utilized for this embodiment of the invention.

Referring next to FIGURE 3, a third embodiment of this invention is disclosed which will now be described. In this embodiment the various elements can be supported in any desirable manner, such as that illustrated in FIGURE 1, and, therefore, no specific supporting means is illustrated to simplify disclosure. An outer cylindrical getter member 30 encloses an inner cylindrical getter member 31 together with a split, or double-sectioned, helical coil heater element having an upper half 32 and a lower half 33. A cap member 34 of getter material can be provided and positioned over the inner cylindrical getter member 31. The top of the upper half 32 of the split heater is electrically and mechanically connected to the top of a conducting, supporting rod 35. Provision is made for electrically connecting only the upper half 32 of the split heater by utilizing a center tap terminal 36 and the supporting rod terminal 37 or for connecting the entire length of the heater by utilizing the terminal 38 of the lower half of the split heater 33 and the supporting rod terminal 37. In the structure disclosed in FIGURE 3, the upper and lower sections 32 and 33, respectively, of the heater can be selectively energized separately or jointly for controlling selectively the heating of the getter members thereby to provide different temperature for the above-discussed reason of obtaining sorption of different active gases.

It will be understood, that in each of the embodiments of the invention herein described, temperature gradients will exist along the dimensions of the getter members, with the higher temperatures being those nearer the heater, rather than only two specific temperatures resulting. This result is desirable since gases gettered at the higher temperatures tend to diffuse through the metal to the cooler areas as the concentration of sorbed gas increases, even though these gases would not be sorbed initially at these cooler temperatures. The effect of the temperature gradient is therefore to increase the gettering ability or capacity for a given mass of material and to provide optimum getter temperature for sorption of hydrogen as well as other gases.

Temperature gradients which cover a greater over-all range of temperature can also be achieved by the addition of further getter members with possible additional heater elements. This idea is carried out in the embodiment of the invention which has been shown in FIGURE 3, since a third getter member, namely, the cap 34, is utilized as well as a split heater design.

The invention herein disclosed may be utilized, as has been previously indicated, within the main body of the envelope of an electron discharge device (not shown) or, if desired, as an appendage to the envelope. Inasmuch as this getter device is independently heated and does not depend upon the functioning of a discharge device, as do the so-called "parasitic getters" or ones which rely upon heat from the cathode heater, its positioning in an existing vacuum tube design can be made with a minimum of redesigning of the electrode elements. Furthermore, as will be understood from the foregoing, this invention is equally well suited to many other types of uses where a high vacuum is desired and not solely to use in connection with electron discharge devices.

While particular embodiments of getter devices employing this invention have been shown and described, it will be understood from the foregoing that changes and modifications can be made without departing from the spirit of the invention and the scope of the appended claims.

What is claimed as new and desired to be secured by Letters Patent of the United States is:

1. A getter device comprising in combination, a plurality of getter members, an independent heater element for said getter members, one of said getter members interposed between said heater element and another of said getter members in heat shielding relationship thereto whereby said one getter member will be heated to a higher temperature than said other getter member to getter a gas not gettered by said other getter member at a lower temperature.

2. A getter device comprising in combination, a first getter member, an independent heater element for said first getter member and closely adjacent thereto, a second getter member interposed in heat shielding relationship between said first getter member and said heater, whereby said second getter member will be heated to a substantially higher temperature than said first getter member to getter a gas not gettered by said first getter member at a lower temperature.

3. A getter device according to claim 2, wherein said getter members comprise a metal selected from the group consisting of titanium, hafnium, and zirconium and combinations thereof.

4. A getter device comprising a longitudinally extending heater element, a first tubular getter member positioned around said heater element and coextensive therewith, and a second tubular getter member positioned

around said first getter member and longer than said first getter member.

5. A getter device comprising a supporting structure, a longitudinally extending heater element mounted on said supporting structure, a first inverted cup-shaped getter member coextensive with and positioned over said heater element, and a second inverted cup-shaped getter member positioned over said first cup-shaped getter and having longer side walls than the side walls of said first getter member.

6. A getter device comprising a supporting structure, a heater element mounted on said supporting structure, a tubular getter member positioned around said heater element, and a plurality of annular getter members positioned around said tubular getter member in an axially spaced stacked array.

7. A getter device according to claim 6, wherein said annular members include longitudinally extending outer rim portions effective for minimizing heat radiation and outward migration of volatile materials from between said annular members.

8. A getter device according to claim 6, wherein said tubular getter member and said annular getter members comprise a metal selected from the group consisting of

titanium, zirconium and hafnium and combinations thereof.

9. A getter device comprising a longitudinally extending heater element with an electric terminal at each end and an electric terminal intermediate the ends dividing said heater into two portions, a first tubular getter member substantially coextensive with one of said two portions of said longitudinally extending heater elements and positioned about it, and a second tubular getter member substantially coextensive with both portions of said longitudinally extending heater element and positioned about said heater element and said first getter member.

10. A getter device according to claim 9, wherein an end cap of getter material is provided on one end of said first tubular getter member.

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